THE SAFETY PARAPET DEVICE REQUIRED FOR SECURITY OF TRAFFIC ON ROAD INFRASTRUCTURE

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Rezumat: *Complexitatea problemelor generate de creşterea explozivă a traficului din ţara noastră, care a condus la o creştere foarte accentuată a accidentelor rutiere, necesită adoptarea unor măsuri concrete privind siguranţa rutieră. Aceste măsuri pot fi luate în special de către administratorul drumului prin instalarea de elemente de semnalizare longitudinală şi orizontală şi prin instalarea de parapete de siguranţă. Parapetul de siguranţă, montat şi întreţinut în mod corespunzător, are scopul de a menţine, opri şi redirecţiona vehiculele pe drum în condiţii bune de siguranţă pentru ceilalţi utilizatori ai drumului, în anumite limite de viteză, masă şi unghi de impact, precum şi pentru a asigura orientarea pietonilor şi altor utilizatori ai drumurilor.*

Abstract: *The complexity of problems resulting from the explosive road traffic growth in our country, which has led to a very high growth of road traffic accidents, requires concrete measures for road safety. These measures can be taken especially by the road manager through a longitudinal and horizontal signalling, correct placement and installation of safety parapets. Safety parapets mounted and maintained properly have the purpose of retaining (stopping) and redirecting vehicles on the road side in good safety conditions for other road users within certain speed limits, mass and impact angle, as well as and to ensure the guidance of pedestrians and other road users.*

Keywords: parapet, safety, traffic.

1. Introduction

Vehicle protection systems have the role of minimizing the consequences of accidents as much as possible. They apply to:

- the protection of the persons involved and / or roadside areas requiring protection or traffic from the opposite way in the case of dual-lane or multi-lane roads;
- the protection of vehicle occupants from leaving the carriageway, for example in the event of overturnings or in the event of a collision with obstacles on the side of the road.

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The performance levels for protection guards and shock absorbers are established on the basis of vehicle protection criteria: the level of protection (N1, N2, H1 ... H4b), severity (STI), shock and deformation expressed in working width W and dynamic deflection D.

The factors to consider are: the road category, its location, the soil configuration, the presence of vulnerable structures, dangerous adjacent areas, unfavourable local weather conditions (frequent fog, smoke, etc.).

The level of protection indicates the capacity of the parapet to withstand its impact with a vehicle of a given total mass at a given speed and below a certain angle in accordance with the tests in SR EN 1317-2.

Dynamic deflection (D): The maximum lateral dynamic lateral displacement of the lateral side of the sill traffic, $D \leq W$ or D may be zero.

Performance class: The performance class of a parapet and the clamping device is determined by the degree of protection, working width (W) and impact degree (ASI).

Shock Severity Level (A, B). The severity of vehicle occupant shock is estimated by acceleration severity indices, ASI, THIV (theoretical head impact velocity), and PHD (post-impact deceleration). The higher the SIA> 1, the greater the risk for passengers exceeds the safety limits.

The dimensioning and checking of the safety sill shall be made to the galling force according to SR EN 1317-2: 2010, considering the vehicle's running on a track in alignment (incidence angle, max. 20° impact) within the impact speed limits 110 ... 65 km/h).

The level of protection for each type of parapet shall be determined by means of shock tests.

Technical description of the safety barrier

The metallic barrier and deformable handrails are elastic metallic structures that are located on traffic sectors and roads that are dangerous for the safety of the traffic, to protect vehicles against roadway exits and to guide them optically. They form an active barrier designed to absorb a significant part of the forces generated by impact by deforming the elements, resulting in the vehicle coming back in the direction of sliding on the rims and the body along the sill without affecting the other road users.

2. Metallic Parapets

Two types of metallic parapets are produced in Romania:

1. The Romanian metallic sill according to STAS 1948/1 and SR 1948-2, where the types of semigreed parapet, heavy, very heavy, combined and pedestrian are distinguished. Currently over 70% of the existing parapets on our roads are parapets belonging to this category. Components have been designed by IPTANA many years ago and have not been tested for their performance.

2. The European metallic sill according to EN 1317-5 + A2: 2012 applicable from 2014 and where the classification is made only from the perspective of the crash test. Thus, the types of parapet N1, N2, H1, H2, H3, H4a and H4b appeared. These types of parapet are currently installed on motorways, national and European roads, county roads. Projects for European parapet systems are carried out by each manufacturer and then approved by testing in accredited laboratories. Performance tests are not valid if the length of a sill-mounted section is less than the length tested by the manufacturer or in accentuated curvature areas where the incident angle of the parapet may exceed 20°. Each type of European parapet is divided depending on the working width W (W1 ... W8) and the severity of the ASI impact (A or B).

Due to the coexistence of the two STAS 1948 and EN 1317-5 + A2: 2012, technical provisions AND 593, of non-updated designations, most designs and specifications contain errors and confusion when choosing the right parapet.

SC PROINVEST GROUP SRL in Pascani is the only Romanian road ramp manufacturer that produces parapets according to STAS 1948 and parapets according to EN 1317. This company has managed to perform crash tests and to approve 4 types of European sill: N2W4, N2W6, H1W4 and H2W6.

The design of the parapet systems was made in accordance with the demands of the market regarding the quality / price ratio and the technological possibilities of the factory. All four types of parapets have a single technological flow, two components: the slide or the slide and the column + assemblies, thus having a simple execution and a simple assembly (Fig. 1-3).

The quality of the steel used is S235JR and S355JR, according to SR EN 10025-2 / 2004, the corrosion protection of the entire system being made by immersion in a molten zinc bath. The zinc layer has a thickness of 60-80 μm.

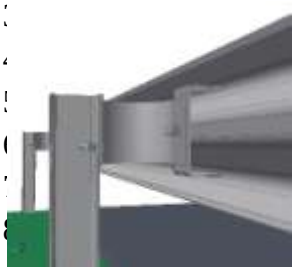
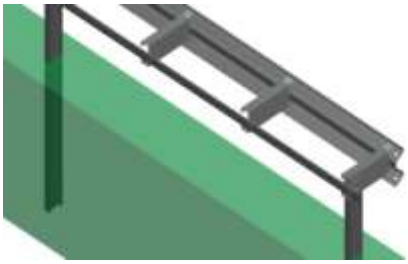
Semi hard	**hard**	**very hard**
		
- lisa - caliper - suffer - pillar IPE100 - assembly parts	- lisa - spacer - pillar - assembly parts	- lisa - flexible type C - damper - pillar IPE100 - assembly parts

Fig. 1: Types of parapets according to STAS 1948

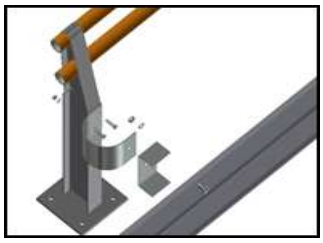
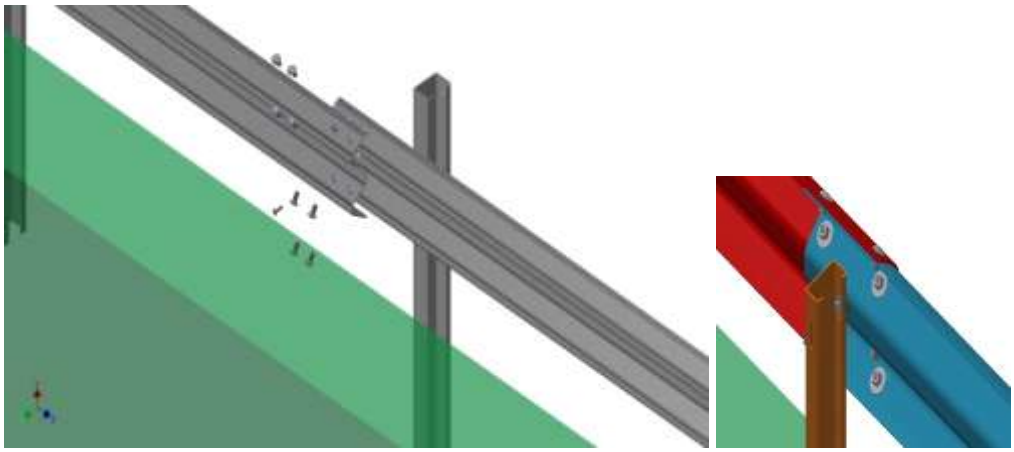
Combined	***Pedestrian - rectangular pipes***	***Pedestrian - round pipes***
		
- lisa - caliper - damper - pillar - handrail - assembly parts.	- panels at 2 or 3 m	- panels at 2 or 3 m

Fig. 2: Components and panels

The types of European sill according to EN 1317 produced by Romanian producers have identical configuration, with only one distance between the pillars.



- lisa
- pillar type C
- assembly parts

Fig. 3: Components with pillar type C

3. Concrete Parapet

Concrete parapet is a device designed for optical guidance and preventing vehicles from getting off the road platform, within certain speed limits, mass and impact angles. The rigid retainer is of a heavy type and is made of C 35/45 or C 35/45 concrete cement C 30/37 and reinforced concrete with a diameter of max. 18 mm. Rigid parapets can be made either by continuous casting of concrete using a Wirtgen SP 250 concrete spreading machine, or by casting prefabricated elements into a formwork and joining the elements on the ground. The Wirtgen is equipped with all the necessary subassemblies to ensure a consistent concrete supply of the sliding formwork, a proper vibration and a smooth surface of the concrete. The components of the guardrails are made as follows: cement concrete class 35/45 according to SR EN 206/1; steel reinforcement with max. 18% according to SR EN 10025.

The rigid concrete retainer is about 3 (three) to 5 (five) times more expensive than the metal elastic straps for the same impact class. This involves a much greater financial effort or because of budgetary restrictions, more and more roads will be made without protection parapets.

The rigid concrete retainer (Fig. 4) as a roadside protection feature in significant continuous segments produces intense stress for road users due to the “tunnel” effect.

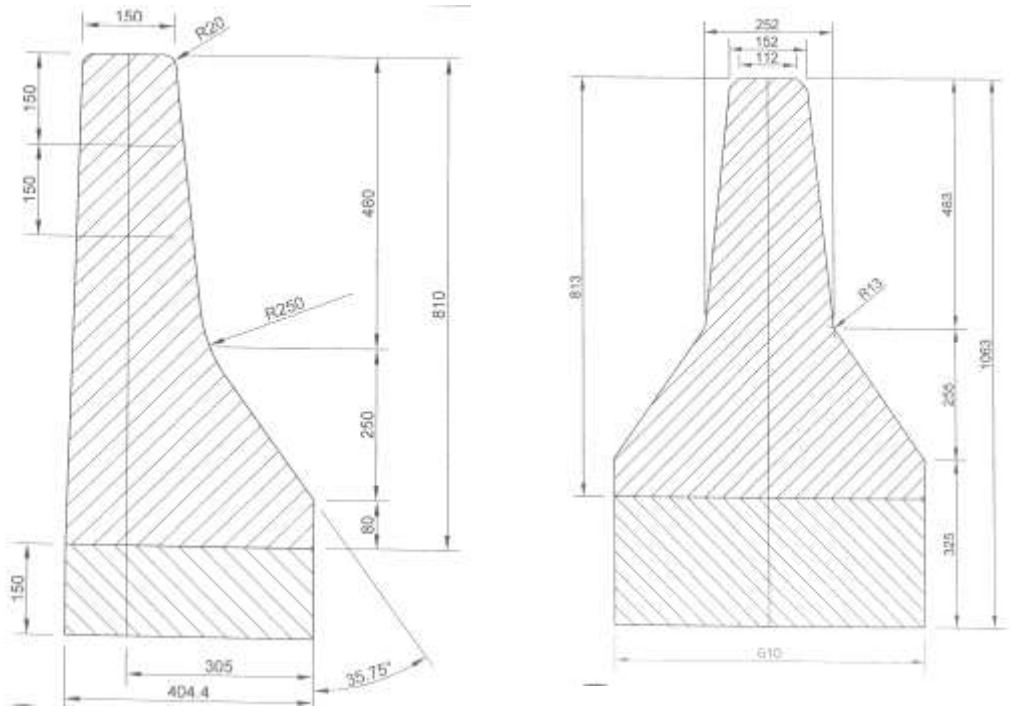


Fig. 4: Concrete parapets

Product conformity assessment "Protective parapets"

The conformity of the road safety device with the requirements of SR EN 1317-5 and with the established values must be demonstrated by:

- Initial Type Test (ITT)
- Factory production control (CPF) by the manufacturer, including product evaluation The Initial Type Test (ITT) consists in carrying out an impact test in the form of destructive testing on impact strength and impact compatibility for different means of transport or related systems and components. The installation of the parapet is done according to the manufacturer's instructions, the soil being compacted successively until reaching the natural soil characteristics. For the bridge parapet, a reinforced concrete beam is made on the track, similar to a bridge. Upon request of special tests, it is possible to perform in the laboratory the conditions similar to the area in which the sill is required.

Vehicles used for testing must be in perfect working order, not to have major accidents and run on European roads. They are placed on the test track and towed up to the required speed by means of a special winch, the car's controls in particular being left free. The inside of the car sets specific sensors that measure the severity of the impact and the behaviour of the car after impact. The vehicle is brought to the weight required by the leaching test, and the seat is placed on its centre of gravity.

The speed at impact is calculated by measuring the time between two points at a distance of 1 m. The impact point is selected at 1/3 of the length of the sill tested in the worst position. Filming takes place with the help of fixed-speed ultrasonic cameras, drones and two other normal video cameras mounted on tripods. After the test is made, measurements are made on permanent deformations. All collected data arrive at the central server and then they are processed. A government observer attends each test to eliminate the risk of fraud in the tests.

The test is considered successful if:
- no elements of the parapet have been detached to penetrate the body of the vehicle;
- the vehicle has not been overturned;
- the car was rejected by the parapet and kept the ride after the impact;

The manufacturer's factory production control must include written procedures (operational), periodic inspections and tests and / or assessments and the use of results for the control of raw materials and other materials or components supplied, the equipment, the production process and the product.

4. Conclusions

Performance certification of a parapet is a mandatory European requirement and is required in the context in which this device can save human lives.

The costs for an impact test are very high, between 20,000 euro and 80,000 euro, without anyone guaranteeing that the test will succeed. 3 to 4 failed tests can be performed until a test has passed. Typically, successive computer simulations are performed before the actual test is performed. Applications on the computer are made using the LS-DYNA software based on the finite element method. A computer simulation costs between 6,000 and 10,000 euro, and a correction costs around 1,500 euro.

The establishment of a testing polygon in Romania in accordance with European standards and accredited as a test laboratory, as well as notified in Brussels, would support the producers of parapets.

R E F E R E N C E S

[1] STAS 1948/1:91 Road Works. Guide Pillars and Parapets. General Requirements for Design and Location on Roads.

[2] SR 1948-2: 1995 Road Works. Wing on the Bridges. General Design and Location Requirements.

[3] EN 1317-2: 2010 Road Safety Devices. Part 2: Performance Classes, Acceptance Criteria for Impact Tests and Test Methods for Safety Parapets.

[4] EN 1317-5+A2:2012 Road Safety Devices. Part 5: Requirements for Products and Conformity Assessment of Vehicle Restraint Devices.

[5] Normativ AND ind 593:2012 *Normativ pentru sisteme de protecție pentru siguranța circulației pe drumuri, poduri şi autostrăzi.*